E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(10): 475-480
Received: 02-08-2024
Accepted: 06-09-2024

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Enhancing the productivity of paddy through frontline demonstrations for SC farmers of Chamarajanagara District, Karnataka

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i10Sg.1824

Abstract
Among Cereals, Paddy is an important cereal crop grown over an area of 18806 ha under Kabini command area with a productivity of 47.80 q/ha and with a yield gap of 37.20 q/ha. As per the Population Census 2011 data The Schedule Caste (SC) constitutes about 25.4% (2, 59, 445) of total population of the district and the literacy rate of SC men and women is very low and unaware of new agricultural practices. As a consequence, ICAR-Krishi Vigyan Kendra, Chamarajanagar district conducted 100 frontline demonstrations on paddy covering an area of 84 ha of farmers' fields in villages' *viz.,* Y K Mole, Irasavadi, Honnuru and Kesturu during the year 2021 and 2022 with a financial support from IIRR Hyderabad under SCSP project to uplift the livelihood security of paddy growing SC people. To enhance the knowledge level of farmers training programmes and demonstrations and media coverage were done to reflect the maximum impact. Totally 19 practices were selected as a criteria to evaluate the farmers to the extent of knowledge gained and adoption of rice production technologies as a result of training programmes conducted. The study revealed that the knowledge gained and adoption of production technologies of rice by farmers ranged from 35.2% to 100% and 26.7 to 100% respectively. The study revealed that the demonstration plots recorded significantly higher mean yield of 61.31 q/ha (30.11% higher) than farmers' practice (47.14 q/ha).The enhancement in yield was mainly attributed to better yield and growth parameters. Further, per day productivity was also higher with demonstration plot (49.1 kg/ha/day) as compared farmers practice (34.9 kg/ha/day). Higher Benefit: Cost ratio of 1.85 was recorded with integrated crop management practices as compared to farmers' practices (1.08). These results indicate that there is a great opportunity for schedule cast farmers of Chamarajanagar district, Karnataka for increasing productivity and profitability of the rice crop by adoption of Integrated Crop Technologies (ICT).

Keywords: Frontline demonstrations, Chamarajanagara, SC farmers

Introduction
Rice is the staple food of over half of the world's population. It is the predominant dietary energy source for more than 34 countries in the world. Rice is the most important food crop for more than 60% of the population (Anon 2012) [1]. The rice yields are still less in India amongst the neighboring countries. In India, more than 70% of the all rice growing districts reported lower yields than the national average. The study reveals that adoption of improved varieties and production technologies is very helpful in tapping 30-40% potential yield. In India paddy is grown in area of 43.79 m ha with a production and productivity of 116.42 m t and 26.55 q/ha respectively (Anonymous, 2018a) [2]. In Karnataka, paddy is cultivated in an area of 1.01 m. ha., with a production and productivity of 2.54 m. t. and 25.22 q/ha, respectively (Anonymous, 2018).
Chamarajanagar district is known for its varied agro-climatic conditions with diversified cropping situation located in Karnataka state. Rainfall is the backbone of Chamarajanagar district agriculture. The cereal crop occupies nearly 50% of the cropped area and 22% under pulses. Thus food grain crops covers 73% of the cropped area. Among Cereals, Paddy is an important cereal crop having an area of 18806 ha under Kabini command area with a productivity of 47.80 q/ha (Anonymous, 2018b) [3].

The parts of Yelanduru, Kollegala and Santemarahalli cover the paddy growing SC farmers' population to an extent of 90%. As per the Population Census 2011 data The Schedule caste constitutes about 25.4% (2, 59, 445) of total population of the district and the literacy rate of men and women is very low and unaware of new agricultural practices. This has led to the yield gap of 37.20 q/ha. This yield gap is likely due to use of local varieties, higher seed rate and plant population, no seed treatment with pesticides and biofertilizers, poor management of nursery, no gypsum application to problematic soils, Imbalanced application of NPK nutrients, lack of knowledge on splits application of nitrogen, micronutrient application, and foliar application of nutrients, lack of knowledge on chemical weed management, unavailability of labors for timely weeding, low water use efficiency, lack of knowledge on integrated pest and disease management practices. In this context the present study was designed with following objectives i.e., enhancing the productivity of rice and livelihood security of rice growing SC farmers through introduction of improved crop management technologies.

Methodology

The study was carried out through conducting training programmes, method demonstrations and Front line demonstrations (84 ha for 210 farmers) during *kharif* 2021 and 2022 in four villages' *viz*., Y.K. Mole, Irasavadi, Honnuru and Kesturu of Chamarajanagar district of Karnataka state for dissemination and popularization of technologies. Group meetings were conducted in selected villages where the problem prevailed with respect to production technologies before demonstration. The interested farmers were opted to conduct the demonstrations after the group meeting. Further, the capacity building programmes were organized by involving the selected farmers and conducted pre and post evaluation response of the farmers to work out the change in knowledge and expressed in percent. In the similar way the pre and post evaluation was done to work out the adoption level of beneficiaries and expressed in %.

Details of Critical Inputs provided: Paddy variety (RNR-15048):25kg; Azospirillum and PSB bio-fertilizer: 200 g each; Londax power pre-emergence herbicide: 4 kg; Zinc sulphate: 8 kg; 28:28:0 water soluble fertilizer for foliar spray: 1 kg; Micronutrient mixture for foliar spray: 1 kg; Carbendazim: 500 g and Chloropyriphos: 500 ml were provided to all the farmers. However during 2021 a sickle was provided to all the 100 beneficiaries. Whereas, during 2022 a tarpaulin was provided to all the 110 beneficiaries.

Details of Technologies: The package of improved technologies like line planting, integrated nutrient management includes micro nutrient application (Zinc sulphate), integrated weed management, water management, seed treatment with systemic insecticides, Azospirillum and PSB and whole package were demonstrated as mentioned in Table 1. Professor Jayashankar Telangana State Agricultural University (PJTSAU) developed a new rice variety namely Telangana Sona (RNR 15048) during 2015. It is a short duration (120-125 days), blast resistant rice variety suitable for both kharif and rabi seasons. It has high (>67%) Head Rice Recovery even in rabi harvests, which is a major advantage to the farmers and millers. It became popular on account of its unique grain size and shape (short slender) besides cooking quality as evident from intermediate estimates of alkali spreading value, gel consistency and amylose. RNR 15048 has been classified under low glycemic index category with values of 51.5.

Observations on different growth (plant height, number of tillers) and yield (productive tillers, panicle length, panicle weight, filled and unfilled grains,% Chaffyness and 1000 seed weight parameters) were taken from five randomly selected plants and economic analysis was done by calculating cost of cultivation, gross returns, net returns and B:C ratio. The yield data were collected from both the demonstration and farmers practice by random crop cutting method and gross return was calculated as per prevailing market prices. Harvest Index was calculated as per the procedure outlined by Gardner *et al*., 1985 [Harvest Index = Economic Yield/ Biological Yield (100)].

Improved rice growing technologies were introduced to targeted farmers through extension approaches through regular follow up field visits, on and off campus training programs to farm men and women, interactions, group discussions and through distribution of technical bulletins on ICM in paddy. Further field days were organized inviting the farmers from other nearby villages and media coverage was also done to reflect the maximum impact. Profitability of the system was calculated by following the procedure outlined by Patil *et al*., 1984. The technology gap, extension gap and the technology index were calculated by adopting suitable formulae (Naik *et al*., 2015 and Sunil *et al*., 2020) [6, 14-15]. Extension gap = Demonstration yield - Farmers' practice yield, Technology gap = Potential yield - Demonstration yield, Technology index = Potential yield - Demonstration yield/Potential yield x 100. The response of technologies demonstrated was similar in both the years of study. Therefore only mean data of two years is discussed.

Further statistical analysis (Z test for two mean) was done for all growth parameters, yield parameters and grain and straw yield, Harvest Index and Production efficiency to check the level of significance (Das and Giri, 2002) [4].

Results and Discussion

Impact of capacity building programme on gain in knowledge level of Beneficiaries: Capacity building programmes play a vital role in gaining the knowledge regarding the improved technologies by farmers. The results pertaining to the change in knowledge level is presented in Table 2. The change in knowledge level of farmers on improved rice production technologies after attending the capacity building programme ranges from 35.2% (Land preparation) to 100% (improved variety). Utmost knowledge gained was on RNR-15048 an improved variety (100%) followed by foliar spray of NPK nutrients (84.8%), Application of micro nutrients (83.8%), Integrated weed management practices (82.9%), Water management during and after transplanting (79%), Seed treatment (76.7%), Seedlings per square meter (75.7%), Seed rate (72.9%), Number of seedlings /hill (71.9%), Balanced dose of NPK Fertilizers (67.6%), Wet nursery Preparation (61%), Appropriate age of seedling for transplanting (57.1%), Application of NK in splits doses (57.1%), Use of need based pesticides (55.2%), Management of nursery (50%), Mechanical harvesting (48.6%), Gypsum application (44.3%), Green manuring (40%) and Land preparation (35.2%). The capacity building programs and method demonstrations organized by the scientists has facilitated the beneficiaries in better understanding of subject in a simple way. The results were in conformity with Singh *et al*. (2014).

Impact of capacity building programme on adoption level of Beneficiaries: Table 3 depicts the data pertaining to adoption level of beneficiaries. The data revealed that most of the farmers were growing local varieties, higher seed rate, no seed treatment, poor management of nursery, 30-35 days old seedlings transplanted @ 3-5 seedlings, Imbalanced NPK application, no application of micro nutrients, No foliar application of NPK, poor water management, less rate of green manure application, No integrated weed management practices, injudicious usage of plant protection chemicals, poor land preparation and less usage of machineries in harvesting before acquiring the training. Whereas, after attending the training programme 100% beneficiaries adopted high yielding and blast resistant rice variety RNR-15048, application of micronutrients (85.7%), proper weed management practices (85.7%), recommended seed rate (74.8%), foliar application of NPK nutrients (71.9%), proper management of nursery (67.1%), transplanting of 20-25 days age old seedling (65.7%), application of balanced NPK (65.8%), doing seed treatment (57.1%), application of NK in split doses (52.9%), @ Number of seedlings per hill (51.4%), recommended and need based plant protection chemicals usage (48.6%), maintaining optimum plant population per square meter (47.6%), proper water management technologies (47.1%), growing green manuring crops (40%), usage of mechanical harvesting (38.1%), gypsum application (36.2%) and proper land preparation (26.7%). Adoption level of beneficiaries increased more than 50% with all the improved practices. However land preparation, gypsum application, mechanical harvesting, green manuring, water management practices, maintain optimum plant population per square meter and wet nursery preparation required further need of trainings as the adoption level were less as compared to other agronomic practices. These findings were in agreement with Singh *et al*. (2014).

Growth and Yield Parameters

The growth and yield parameters are depicted in Figure 1. Adoption of RNR-15048 with improved crop management practices has recorded significantly higher plant height (87.6 cm), Number of tillers per hill (25.8), productive tillers (21.6), panicle length (25.3 cm), panicle weight (4.14 g), 1000 grain weight (14.52 g), number of filled grains (303.9) with less% of Chaffyness (10.9%) as compared to IR-64 with farmers practices (60.75 cm, 19.4, 15.35, 23.15 cm, 2.76 g, 27.01 g, 90 and 22.35%, respectively). This difference is mainly attributed to their genetic variability and varietal difference. These findings were in corroborated with findings of Sarker *et al*. (2013) and Pandey and Shukla (2015) [7].

Grain yield, Straw yield and Production efficiency

Growing of RNR-15048 with improved management practices has recorded significantly higher grain yield (61.31 q/ha) which was 30.11% higher than farmers practice with IR-64 (47.14). This might be due to better growth and yield parameters (Figure-1). However the straw yield has also followed the similar trend as in case of grain yield. This might be due to better biomass production (Sunil *et al*., 2020; Samant, 2017) [14-15, 9].

Further the production efficiency was significantly higher with RNR-15048 (49.1 kg/ha/day) as compared to IR-64 (34.9 kg/ha/day). This might be due to production of higher vegetative biomass and number of productive tillers per hill and more number of grains per panicle with less Chaffyness (Tripathi *et al*., 2013) [16].

Technology gap, Extension gap and Technology index

In demonstration plots the technology gap of 14.89 q/ha was recorded (Table-5). Technology gap shows that there is need to create further awareness among the farmers about the improved crop management practices through various extension means (Mandavkar *et al*., 2012) [5]. The lower extension gap of 14.17 q/ha was recorded (Table-5). It may be due to higher yield of paddy variety in demonstration plots. Adoption of new improved production technologies with new high yielding and disease resistance variety has helped in reducing the extension gap. These results were in conformity with Sharma *et al.* (2011). Technology index showed the feasibility of the evolved technology at the farmers' fields. Lower value of technology index meant more feasibility of disseminated technology. The technology index was 18.25% [Table-5]. This might be due to variations in soil fertility, environmental variation and infestation of pest (Sunil *et al*., 2020) [14-15]. Similar results were obtained with Sujathamma *et al*. (2015) [13].

Economics

The economics is presented in table 6. The average cost of cultivation was higher in farmers practice (₹73216/ha) as compared to demonstration plots (₹70132/ha). This was mainly attributed to reduction in weeding cost and seed cost. Higher gross and net returns of ₹130049 & 59917/ha, respectively was obtained with demonstrated plots as compared to farmers practices (₹78790 and 5575, respectively) and similar trend was also observed with B: C ratio. The results were in conformity with findings of Samant (2014) and Raj *et al*. (2014) [8].

Suggestions from FLD farmers for further adoption of technologies

- Farmers requested to make available of RNR-15048 hybrid rice under seed chain with subsidy as it is costly to purchase directly from market.
- Farmers requested to make available the biofertilizers in Raita Samparka Kendras for easy access.
- New broad spectrum herbicide molecules recommended in package of practice are not available in nearby pesticide shops during the season and requested to make arrangements.
- Farmers requested for subsurface drainage on community basis under government subsidy schemes because water stagnation in field has resulted in increase in saline soils and its becoming too difficult for the movement of combine harvester into the field. This has resulted in late harvesting of crop which leads to shattering of grains in turn more yield loss.

Table 1: Particulars showing the details of paddy grown under FLD and farmers' practice

Particulars	Farmers Practice	Technology intervention	Gap
Variety	IR-64	RNR-15048	Full Gap
Seed rate	70-80 kg/ha	35-40 kg/ha	Higher seed rate
Seed Treatment	Not practicing seed treatment with chemicals (prevention of blast disease) and biofertilizers	Seed treatment with carbendazim 2 g/kg seed fb Azospirillum and PSB treatment @ 500 g/ha each respectively.	Full Gap
Wet nursery Preparation and its management	Nursery bed prepared in 0.25 ha area and imbalanced nutrient management.	Nursery bed prepared in 0.75 ha area & Balanced nutrient management.	Full gap
Age of seedling for transplanting & Number of seedlings /hill	Planting of 28-35 days old seedlings @ 3-5 seedlings	Planting of 20-25 days old seedlings @1-2 seedlings	Full Gap
Nutrient Management	Application of green manures/FYM if available and imbalanced application of major nutrients and no micronutrients applied	Incorporation of gypsum @ 200kg/ha during main land preparation, Application green manure @ 7-8t/ha or FYM 3t/ha, RDF @ 100:50:50 NPK kg/ha, $ZnSO_4$ @ 20 kg/ha	Partial Gap
Water management	Continuous standing water has reduced root growth as well as reduced no. of tillers due to poor aeration and reduced water use efficiency	After transplanting up to 10-15 days water should be stagnated to a height of 2.5cm further 5.0 cm water should be maintained till maturity. For better tillering and aeration one day gap should be provided between two irrigation intervals.	Full gap
Weed Management	Hand weeding	Application of pre emergence herbicide Bensulfuron methyl + pretilachlor (6.6% G) (Londax Power) @ 10 kg/ha fb by one hand weeding @ 45 DAT. or post emergent application of Bispyribac sodium 10% SC @ 250 ml/ha	Partial Gap
Plant protection	Not adopted as per package of practice	Adopted as per package of practice	Partial Gap
Harvesting & threshing	Both manually & use of Combined harvesters	use of Combined harvesters	Partial Gap

Table 2: Impact of training programme on gain in knowledge level of beneficiaries

Sl. No.	Improved technologies	Before	Ranking	After	Ranking	Gain in knowledge level	Ranking
1	Green manuring	30 (30.0)	V	70 (70.0)	XV	40 (40.0)	XVII
2	Land Preparation	60 (60.0)	I	95	II	35 (35.0)	XVIII
3	RNR-15048	0 (0.00)	XVII	100 (100.0)	II	100 (100.0)	I
4	Seed rate	20 (20.0)	X	93 (93.0)	V	73 (73.0)	VIII
5	Seed treatment	13 (13.0)	XIV	90 (90.0)	VII	77 (77.0)	VI
6	Wet nursery Preparation	27 (27.0)	VI	88 (88.0)	IX	61 (61.0)	XI
7	Management of nursery	25 (25.0)	VII	75 (75.00)	XIV	50 (50.0)	XIV
8	Appropriate age of seedling for transplanting	20 (20.0)	IX	78 (78.0)	XIII	57 (57.0)	XII
9	Gypsum application	23 (23.0)	VIII	67 (67.0)	XVI	44 (44.0)	XVI
10	Balanced dose of NPK Fertilizers	15 (15.0)	XIII	83 (83.0)	XII	68 (68.0)	X
11	Application of NK in splits doses	36 (36.0)	III	93 (93.0)	V	57 (57.0)	XII
12	Application of micronutrients	8 (08.0)	XV	94 (94.0)	III	84 (84.0)	III
13	Application of foliar spray of NPK	0 (0.00)	XVII	85 (85.0)	XI	85 (85.0)	II
14	Number of seedlings /hill	20 (20.0)	X	92 (92.0)	VI	72 (72.0)	IX
15	Seedlings per square meter	18 (18.0)	XI	94 (94.0)	III	76 (76.0)	VII
16	Water management during and after transplanting	10 (10.0)	XVI	89 (89.0)	X	79 (79.0)	V
17	Integrated weed management practices	17 (17.0)	XII	100 (100.0)	I	83 (83.0)	IV
18	Use of need based pesticides	34 (34.0)	IV	89 (89.0)	VIII	55 (55.0)	XIII
19	Mechanical harvesting	37 (37.0)	II	85 (85.0)	XI	48 (48.0)	XV

Note: Figures in parentheses indicate percentage

Table 3: Impact of training programme on adoption level of Beneficiaries

	Improved technology	Before	Ranking	After	Ranking	Gain in knowledge level	Ranking
1	Green manuring	25 (25.0)	III	65 (65.0)	XIII	40 (40.0)	XIV
2	Land Preparation	65 (65.0)	I	92 (92.0)	III	27 (27.0)	XVII
3	RNR-15048	0 (0.00)	XII	100 (100.0)	I	100 (100.0)	I
4	Seed rate	15 (15.0)	VIII	90 (90.0)	IV	75 (75.0)	III
5	Seed treatment	9 (9.0)	XII	66 (66.0)	XII	57 (57.0)	VIII
6	Wet nursery Preparation	23 (23.0)	IV	72 (72.0)	X	49 (49.0)	XIII
7	Management of nursery	18 (18.0)	VI	85 (85.0)	IV	67 (67.0)	V
8	Appropriate age of seedling for transplanting	16 (16.0)	VII	82 (82.0)	VI	66 (66.0)	VI
9	Gypsum application	19 (19.0)	V	55 (55.0)	XV	36 (36.0)	XVI
10	Balanced dose of NPK Fertilizers	15 (15.0)	VIII	80 (80.0)	VIII	65 (65.0)	VII
11	Application of NK in splits doses	28 (28.0)	III	81 (81.0)	VII	53 (53.0)	IX
12	Application of micronutrients	8 (8.0)	XI	94 (94.0)	II	86 (86.0)	II
13	Application of foliar spray of NPK	0 (0.00)	XII	72 (72.0)	X	72 (72.0)	IV
14	Number of seedlings /hill	16 (16)	VII	68 (68.0)	XI	52 (52.0)	X
15	seedling per square meter	15 (15.0)	VIII	63 (63.0)	XIV	48 (48.0)	XII
16	Water management during and after transplanting	8 (8.0)	XI	55 (55.0)	XV	47 (47.0)	XIII
17	Integrated weed management practices	14 (14.0)	IX	100 (100.0)	I	86 (86.0)	II
18	Use of need based pesticides	20 (20.0)	III	74 (74.0)	IX	54 (54.0)	XI
19	Mechanical harvesting	34 (34.0)	II	72 (72.0)	X	38 (38.0)	XV

Note: Figures in parentheses indicate percentage.

Table 4: Effect of front line demonstrations on grain and straw yield, harvest index and production efficiency of paddy

Particulars	Demonstration	Farmers Practice	Z value $p \leq 0.01$
Grain yield (q/ha)	60.11±4.23	47.74±2.24	20.99**
Straw yield (q/ha)	67.99±4.82	56.76±2.59	16.59**
Additional yield over farmers practice	12.37 q/ha		
% increase in grain yield over check (%)	25.91%		
Harvest Index (%)	49.5±3.83	41.7±1.85	15.24**
Production efficiency (kg $ha^{-1}day^{-1}$)	48.1±3.38	35.4±1.66	27.90**

Table 5: Economic analysis of front line demonstration on rice at farmer's field

Sl. No.	Particulars	Demo	Farmers Practice
1	Cost of cultivation (Rs./ha)	67023	70150
	Additional cost in farmers practice (Rs./ha)	3127	
2	Sale price of grain (Rs./quintal)	1920	1430
3	Gross returns (Rs./ha)	122880	76384
4	Extra returns over farmer practice (Rs./ha)	46496	
5	Net returns (Rs./ha)	55867	6000
6	B:C Ratio	1.83	1.09

Table 6: Technological gap analysis of frontline demonstrations on ICM of paddy in farmers' field

Year	Area (ha)	No. of farmers	Grain Yield (q/ha)			Technology Gap (q/ha)	Extension Gap (q/ha)	Technology Index (%)
			Potential	Demo	Control			
2021-22	40.0	100	75.0	60.11	47.74	14.89	12.37	19.85

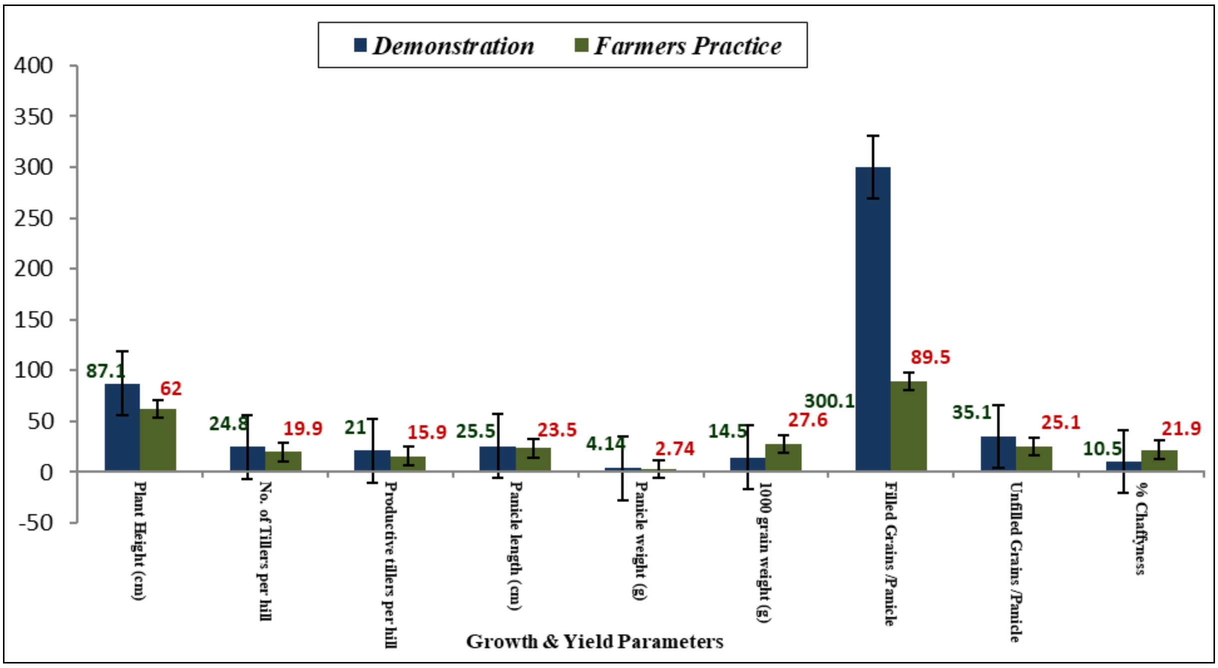

Fig 1: Effect of integrated crop management practices on growth & yield of paddy

Conclusion

The study revealed that a wide gap existed in potential and demonstration yield in rice varieties due to technology and extension gap among SC farmers of Chamarajanagar district of Karnataka. Thus, the cultivation of rice with improved technologies has been found more productive. This has increased the income as well as livelihood of the SC farming community. Further efforts are being made by way of organizing different extension activities for motivating the SC farmers for further popularization and adoption of rice production technologies.

Acknowledgement

We gratefully acknowledge the financial support received from ICAR- Indian Institute of Rice Research, Rajendranagar, Hyderabad – 500 030.

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